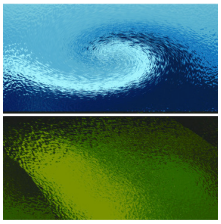
Transitional Waters Bulletin
TWB, Transit. Waters Bull. 8.(2014), n. 1, 24-31
ISSN 1825-229X, DOI 10.1285/i1825229Xv8n1p24
http://siba-ese.unisalento.it



RESEARCH ARTICLE

Spatial variability in the population structure of the *Carcinus aestuarii* in Varano lagoon

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Abstract

1 - This study analyses some aspects of *Carcinus aestuarii* biology within the project MOLEVAR (Pilot Project For The Production Of Moleche (*C. aestuarii*): New Economy For Varano Lagoon) funded by FEP-Puglia 2007-2013 (European Funds for Fishing) in order to evaluate the crabs, *Carcinus aestuarii*, as a new economic resource for Varano Lagoon (Southern Italy).

2 - The Varano lagoon is located on the Northern coast of the Gargano Promontory (Southern Adriatic Sea). The lagoon and the neighboring coastal area are exploited by mussel farming, although such activity was recently reduced within the lagoon, where the fishery is now the most important resource.

3 - The population structure of *C. aestuarii* will be studied in three different sites of the Varano lagoon. A total of 205 specimens were obtained from May to December 2012; 192 males and 13 females were observed. Length (CL) and width (CW) of the carapace and total weight (TW), were determined sex ratio. The overall sex ratio was in favor of males (χ^2= 11.08). At the same time, water temperature, salinity, were measured with a multiparametric probe.

4 - The ovigerous females (n=2) were caught only December in Capojale site. The catches highest (n=46) were recorded in June month in the Capojale site. The highest abundance was found during June 2012 (44 males and 2 females) of which 23 in Capojale, 22 in Varano and 1 specimen in San Nicola Imbuti station, respectively.

5 - The information on the abundance, life cycle and functional role of this crab is still lacking for Varano lagoon. The data so far do not allow us to have a complete picture of the dynamics of the population, especially because it lacks most of the female component.

Keywords: Varano lagoon, Decapod, *Carcinus aestuarii*, Biometrics characteristics, Population structure

Introduction

The Mediterranean green crab, *Carcinus aestuarii* Nardò (1847) is a common inhabitant of the shallow waters. The species is commonly distributed in Mediterranean lagoon and estuarine waters (Mori *et al.*, 1990) from the Levantine Sea coast of Turkey in the Aegean Sea to the Turkish Straits System and Black Sea (Kocataş and Katağan, 2003) being alsod reported in the Suez Canal (Holtuis and Gottlieb, 1958) as well as along the Japan coast (Sakai, 1986; Ikeda, 1989).

C. aestuarii plays an important role in brackish waters as component of diet for eel and seabass (Mori *et al.*, 1990). In the Varano lagoon *C. aestuarii* is a common species of fisheries however the knowledge of the bio-ecology of the species is still lacking.

C. aestuarii has little economic value in Italy, but is of local economic importance in some areas of North Adriatic. In the lagoon of Venice ad esempio the fishing of *C. aestuarii* resulted an important economic activity. In fact, fishermen select crabs during moulting, when they lose the carapace and become soft and a very appreciated daintiness namedon the market as "moleche". This is a seasonal activity mainly occurring in spring and autumn that follows growth rates of crabs. this study analyses some aspects of *C. aestuarii* bio-ecology as part of the research project MOLEVAR (Pilot Project For The Production of Moleche (*Carcinus aestuarii*): New Economy for Varano Lagoon funded by FEP (European Funds for Fishing). The preliminary results on the population structure of this species in the Varano lagoon were provided in three different sites within of the lagoon.

Materials and methods

Study area

The Varano lagoon is located on the Northern coast of the Gargano Promontory (Southern Adriatic Sea) (41.88°N; 15.75°E). The lagoon covers an area of 6,500 ha, with a perimeter of 33 km. The average depth is 4 m, with a maximum value of 5 m in the central zone. The lagoon is partially isolated through a coastal barrier, characterized in both the western and eastern sides by the, Capojale and Varano channels (Fig. 1). Making possible the communication with the sea through the hydrodynamic balance produced by tide, wind strength and anthropogenic action. Salinity values are relatively stable for a brachish lagoon, ever dropping below 20 psu. Temperatures ranged between 5 and 30°C. The hydrological system consists of the lake itself, 2 connecting channels with the sea, freshwater inputs from local torrents and a drainage pumping station as well as several stream springs. Hydrological investigations on the water balance of the lagoon estimated a freshwater input of approximately 87,000 m^3d^{-1} with an organic content mostly originating from urban and agricultural runoff, fish-farming and zoo-technique activities (Villani *et al.*, 2000; Spagnoli *et al.*, 2002). Due to the low tide excursion and reduced exchange with the adjacent coastal area, water time residence is very long and it is estimated to about 1.5 years (Specchiulli *et al.,* 2008).The lagoon and the neighboring coastal area are exploited by mussel farming, although such activity was recently reduced within the lagoon, where the fishery is now the most important resource (Breber and Scirocco, 1998).

Sampling design

Sampling of *C. aestuarii* occurred monthly, from May 2012 to December 2012 in 3 different stations Capojale,Varano Mouths and San Nicola Imbuti.

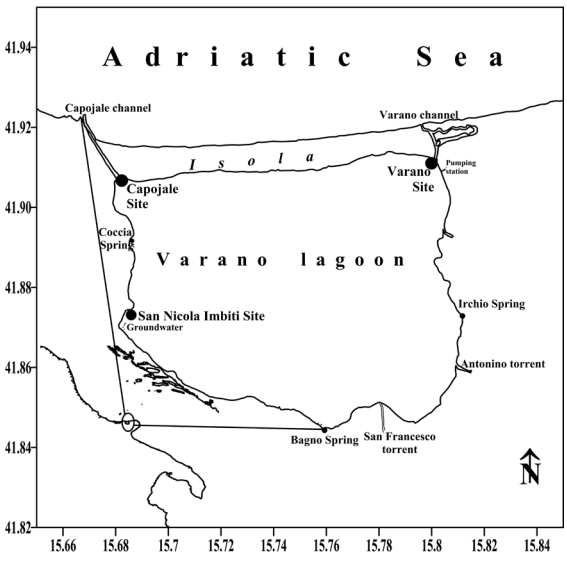

Figure 1. Sampling sites in Varano lagoon.

In each station the main environmental parameters were recorded by mean multiparametric probe (Temperature in °C, Salinity in psu). Crabs were captured using traps and lines net at depths no deeper than 2 m, deployed for approximately 32 h. Traps were made of nylon, 2x2 cm mesh size, measuring approximately 145 cm in length, 65 cm in width and 45 cm in height.

Laboratory procedures

Once captured, crabs were transported into a laboratory and were euthanized in a freezer at -4°C for 1 hour. Crab were counted, measured (Carapace width-CW mm, Carapace Length-CL in mm, Wet weight-WW g). Sex was determined by the shape of the abdomen.

Data analysis

The changes in the number of crabs sampled in each station, their size distribution as well as the sex ratio were monthly recorded. The χ^2 test was used to analyzed the sex ratio. The CW, CL and WW relationship were estimated by the least squares regression method. The spatio-temporal changes in the biological parameters were assessed by the ANOVA test.

Results

Environmental data showed a typical seasonal pattern in each sampling station. In August 2012, salinity ranged from a minimum of 22 psu in San Nicola Imbuti to a maximum of 36 psu in Capojale. Temperature varied from a minimum of 19°C in San Nicola Imbuti May 2012 to a maximum of 31°C (August 2012) (Fig. 2).

A total of 192 males and 13 females were collected during the investigated period. Few females were sampled during the study and in December 2012 two ovigerous females were collected in the Capojale station. The distribution of specimens by sexes and sampling dates is showed in figure 3.

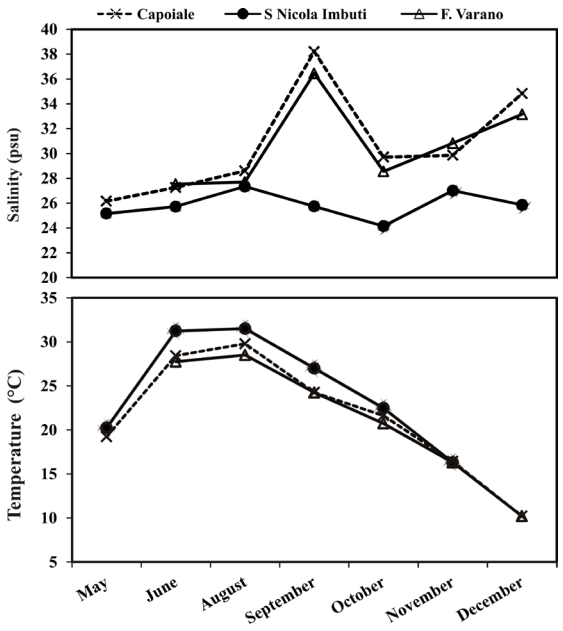

Figure 2. Environmental parameters in the sampling sites.

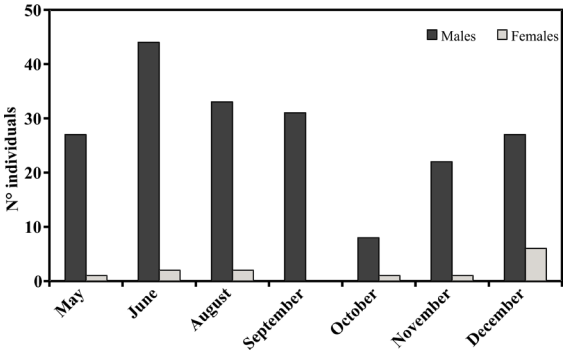

Figure 3. Monthly distribution of males and females.

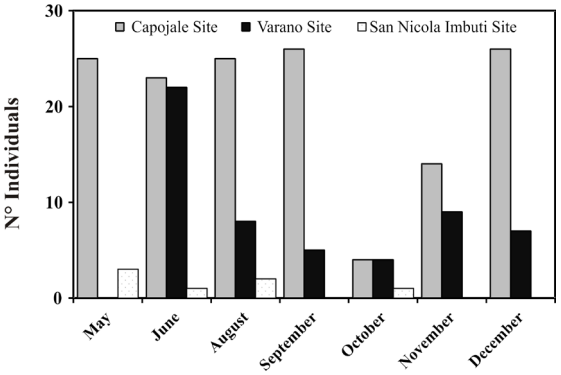

Figure 4. Monthly distribution in each sampling site.

Table 1 - CW, CL and WW characteristic of the C. aestuarii , Mean±SD , minimum (Min) and maximum (Max).

	CW (mm)				CL (mm)				WW(g)			
Sex	**Mean ± SD**		**Min**	**Max**	**Mean ± SD**		**Min**	**Max**	**Mean ± SD**		**Min**	**Max**
Males	49.56 ± 7.01		23	63	42.58 ± 5.95		18	54	44.04 ± 16.09		6.00	79
Females	38.00 ± 5.29		24	46	33.15 ± 4.56		22	40	19.15 ± 6.84		5.60	30
All	48.83 ± 7.46		23	63	41.99 ± 6.30		18	54	42.46 ± 16.79		5.60	79

The figure 4 showed monthly crab abundance values in each sampling station. The highest abundance was found during June 2012 (44 males and 2 females) of which 23 in Capojale, 22 in Varano and 1 specimen in San Nicola Imbuti station, respectively.

In San Nicola Imbuti, no *C. aestuarii* were found between September and December 2012. The morphometric characteristics varied between 23 and 63 mm CW, 18 and 54 mm CL, 6.1 and 79.02 g WW for males. The differences between the morphometric characters (CW, CL, WW were showed in table 1; the size of female varied between 24 and 46 mm CW, 22 and 40 mm CL, 6 and 30 g WW. The size distribution (CW, CL, WW) of both males and females showed a predominance of males with the mean size in male exceeding that of female (Fig. 5).

The size distributions of CW and CL in males showed a mode of 50-55 mm (33.3%) and 40-45 mm (35.4%), respectively. For the wet weighed, the mode was 51-60 g (22.4%). In females, the size distribution of CW is 36-40 mm (46.15%), CL 31.35 (46.15%), WW 11-20 g (46.15%). Temporal differences were observed for CW ($p<0.05$) and spatial differences in both CW, CL, WW ($p<0.001$). The overall sex ratio was clearly in favor of males ($\chi^2= 11.08 < \chi^2_{7,0.05} =14.07$) (Fig. 6). There is no association between month and abundance, the observed variation was random.

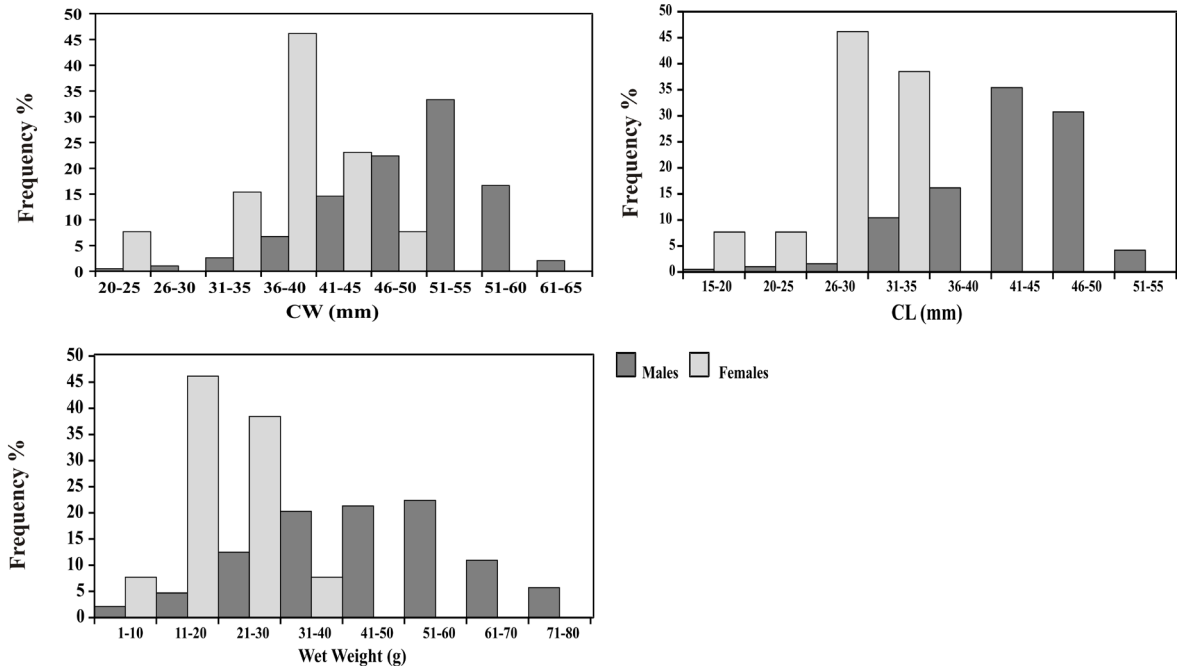

Figure 5. Size frequency distribution of males and females.

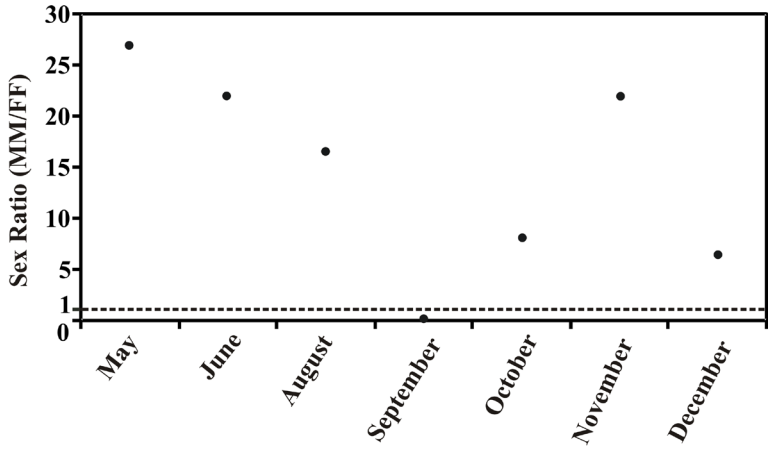

Figure 6. Monthly distribution of the sex ratio of *C. aestuarii*.

The environmental and biological parameters do not appear to be correlated (Table 2).
Regression analyses between CW, CL, and WW for males, females, and both sexes combined are presented in Fig. 7, which shows a high positive linear relationship between these variable. Determination correlation coefficient values (r^2) in male specimens were the highest CL (0.763) in relation to WW (Fig. 7).
Regression analyses gave similar results in females where correlation coefficient values were the highest CL (0.790) in relation to WW (Fig. 7).

Table 2 - Regression parameters of relationship between biometrics characteristic (CW, CL and WW) and environmental data.

	Temperture (°C)		Salinity (psu)	
	r	p	r	p
CW (mm)	-0.0315	0.654	0.0723	0.303
CL (mm)	-0.0554	0.43	0.494	0.494
WW (g)	-0.0701	0.318	0.0711	0.311

Discussion and conclusion

Decapod crustaceans are important ecological components of the marine ecosystem and play a vital role in the intermediate trophic level (Farina *et al.*, 1997). The *C. aestuarii* colonized several regions outside its native ranges, including Australia, Tasmania, South Africa, Japan and both coasts of North America, probably due to its high tolerance to air exposure, starvation and variations in temperature and salinity (Yamada and Hauck, 2001; Roman and Palumbi, 2004). Portunid crabs are important predators that may locally control abundance and distribution of populations of their benthic prey. Along the Italian coasts, *C. aestuarii* is common in estuarine areas, such as at the Lagoon of Venice and at the Lagoon of Orbetello. This very preliminary work aimed to lay the groundwork of knowledge on the bio-ecology of *C. aestuarii* in the lagoon of Varano. The biometrics relationship (CW, LW, WW) is an important factor in the biological study of fishes or crustacean and their stock assessments (Lagler, 1968). The comparisons of biometric correlations of population of *C. aestuarii*, males, females and both sexes combined, has shown a notable similarity with population from different Mediterranean lagoons (Mori *et al.,* 1990; Ozcan *et al.,* 2009; Kocak *et al.,* 2011) . Environmental variability is known to be high in the study area, particularly concerning salinity and temperature variations (Belmonte *et al.,* 2011; Specchiulli *et al.,* 2010). The results so far showed that the collected crabs prefer areas closest to the sea. In fact, Capojale

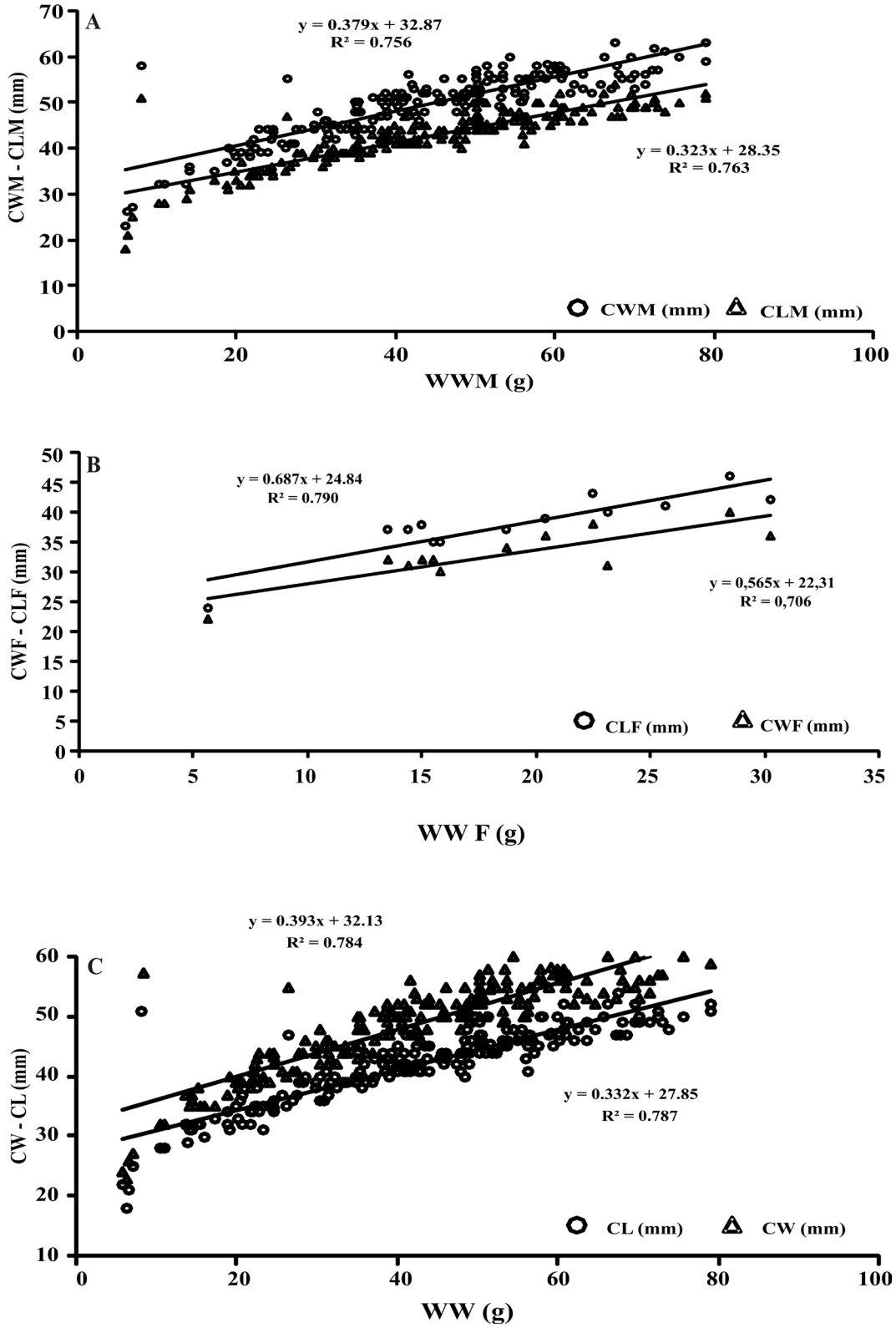

Figure 7. Scatter plot diagrams between CW-WW, and CL-WW far males (A), females (B), males and females (C).

showed the highest number of catches. The more confined area San Nicola Imbuti characterized by the presence of fresh ground water showed the lower catches. Differences in morphometric parameters by sexes (CL, CW, and WW) observed in the Varano lagoon are in agreement with what reported for species in other study area: San Teodoro (Island of Sardinia, Italy), Acquatina lake (South Adriatic Sea, Italy), Homa lagoon, (Easter Aegean, Turkey) (Mori *et al.* 1990; Lumare *et al.* 2009; Kocak *et al.* 2011; Ozbek *et al.* 2012).The sex ratio shows that males clearly dominate over females as found by Lumare *et al.* (2009) in the Acquatina lake (South Adriatic Sea). In general, the information on the abundance, life cycle and functional role of this crab is still lacking for Varano lagoon. The data so far do not allow us to have a complete picture of the dynamics of the population, especially because it lacks most of the female component.

Acknowledgements

This paper was carried out under the project by EFF – Puglia 2007-2013 (European Funds for Fishing). The authors are grateful to Dr. Primiano Schiavone for your help during samplings.

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